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## Application of Cone Penetrometer Technology to Environmental Site Characterization and Remediation

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### Historical Perspective

- Argonne has been very actively engaged in environmental site characterization studies since the early 1990s.
- Argonne is a strong proponent of the application of CPT technology to environmental studies and has actively participated in the development and testing of new equipment and concepts specifically for this application.
- Argonne has utilized cone penetrometer technology as a primary means of data acquisition in support of site characterization efforts:
  - 40-Ton Truck-Mounted unit (ARA/Vertek-1992)
  - Track-Mounted "Crawler" unit—20 Ton (A.P. van Den Berg-2000)



### Advantages of Cone Penetrometer Technology in Environmental Site Characterization

- Minimizes exposure of personnel to hazardous materials by reducing direct contact with contaminated soils and waters.
- Markedly reduces the amount and nature of potentially hazardous waste produced by the direct-push process.
- Avoids increased regulatory requirements and oversight for disposal of hazardous waste, with associated increased costs.
- Minimally invasive, efficient, and cost effective.

### Programmatic Cone Penetrometer (CPT) Functions

- Performance of periodic water sampling events required for long-term monitoring programs.
- Verification of contaminant migration models.
- Primary subsurface exploration tool at all phases of the site characterization process.
- Installation of piezometers/sand point wells for both long- and short-term monitoring of water levels.
- Support for research related to continued development of technologies applicable to CCC/USDA—ANL Program, such as the capacity to perform slug tests.

### Acquisition of Electronic Data

- Different utilization and interpretation of the same data acquired in support of geotechnical engineering—bearing strength, liquefaction potential, etc. not primary factors.
- Principal utilization of the electronic data:
  - Identification of major stratigraphic/lithologic units
  - Identification of hydrostratigraphic units
  - Identification of contaminant-bearing zones

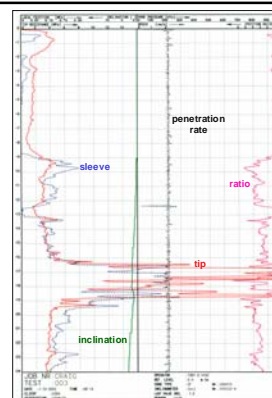


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### Electronic Measurements

- Tip resistance
- Sleeve friction
- Ratio of T/S
- Penetration rate
- Inclination—variation from true vertical

All primary factors



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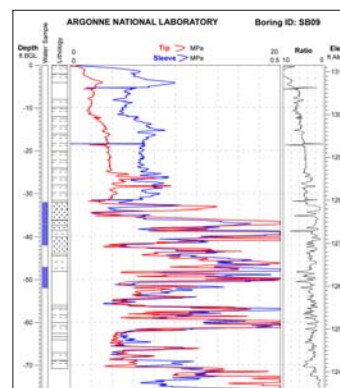
### Identification of Major Stratigraphic/Lithologic Units

- Calibration of cone penetrometer data to core.
- Correlation with regional, local, and site-specific stratigraphy.



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### Calibration of Cone Penetrometer Data to Core

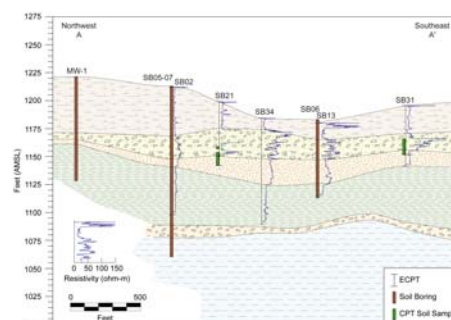


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### Stratigraphic/Structural Cross Section Based on Cone Penetrometer Data, with Confirmation by Selective Coring

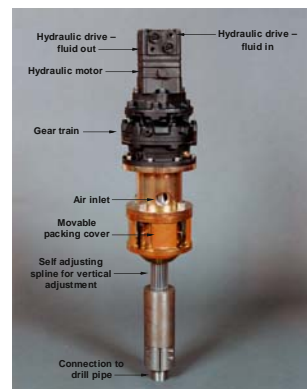


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### Various Methodologies for Acquisition of Core Utilizing Cone Penetrometer

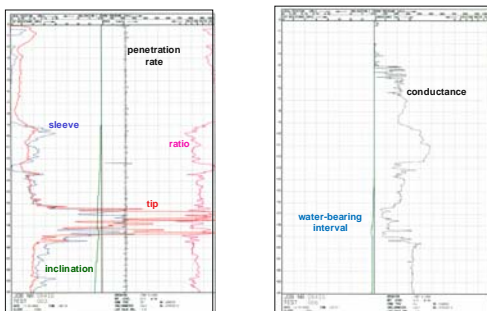


### ANL Power Swivel

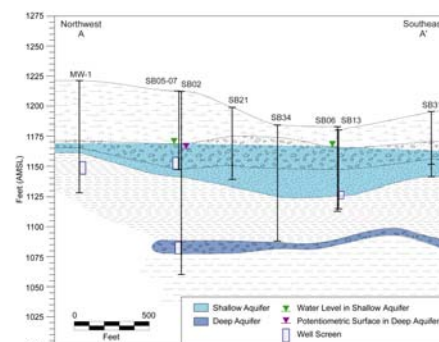


### Identification of Major Hydrostratigraphic Units

- Identification of water-bearing units through ECPT data analysis, comparison with recovered core, and direct observation.



### Hydrostratigraphic Cross Section

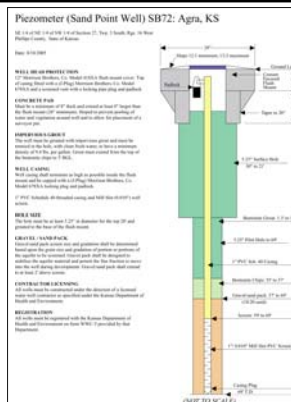


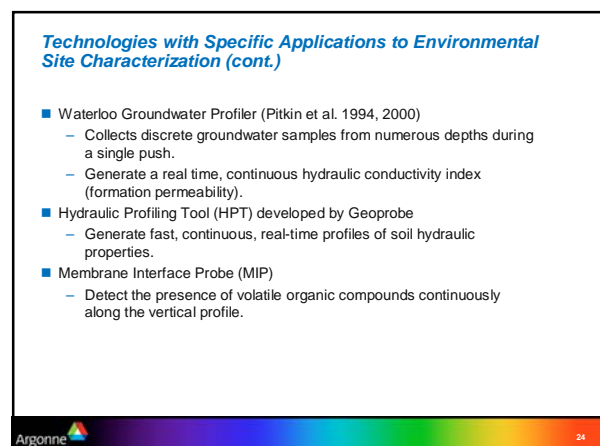
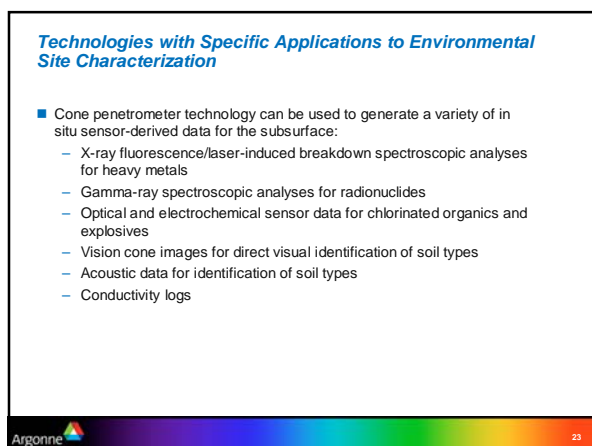
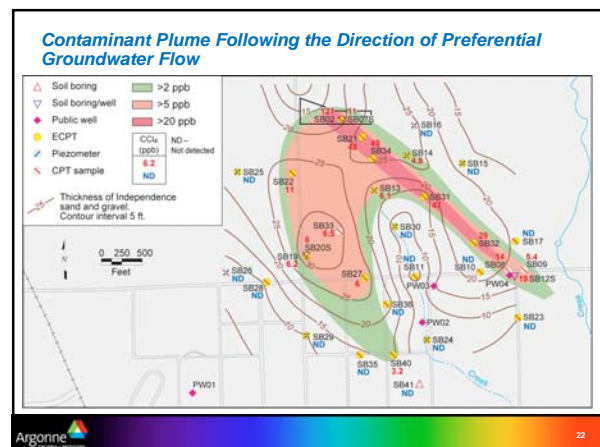
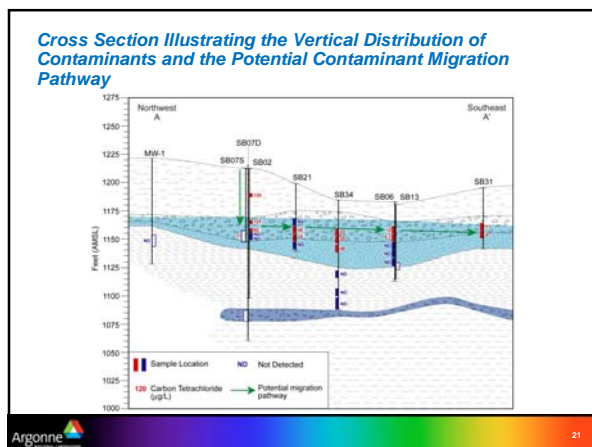
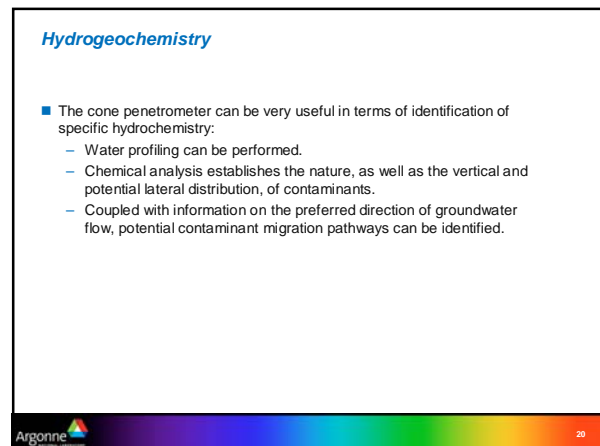
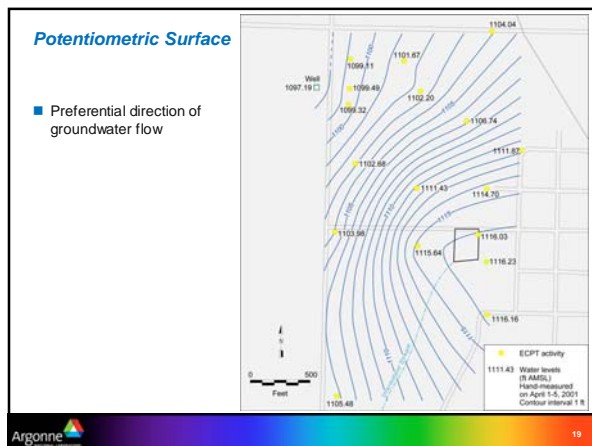
### Installation of Piezometers—Sand Point Wells Through Use of CPT

- Monitor groundwater levels.
- Provide ability to retrieve groundwater samples to track contaminant levels and plume movement.
- Test to determine aquifer capacity and hydraulic conductivity in support of modeling efforts.
- Determine primary flow direction of the significant aquifers and the effects of localized pumping activities on flow direction and plume movement.



### Piezometer Diagram





### *Cone Penetrometer Technology Supports Site Cleanup*

#### **Pre-remediation**

- Aquifer/pump testing to define aquifer properties in the identification of potential remedial alternatives.
- Identification of in situ microbial communities—Bioremediation approach.

#### **Remediation**

- Inoculation with contaminant-specific designer microbial communities.
- Application of nutrient in support of those communities.
- Monitoring activities to define the progress of remediation and the achievement of regulator-defined milestones and compliance goals.



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### *CPT Ejector Tool*



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### *Summary: Environmental Application of Cone Penetrometer Technology*

- Allows for the application of best available technology to achieve the accurate characterization of subsurface stratigraphic and hydrologic conditions.
- Augmented by the ability to obtain data related to the hydrogeochemistry—contaminant identification, as well as distribution.
- Ability to provide data in support of the selection and testing of potentially most appropriate remedial technology.
- Assists in the application of the identified and approved remediation technique where appropriate.
- Subsequent monitoring of its effectiveness and necessity to modify to achieve optimal remedial effects.



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### *In Summary*

- CPT technology can be utilized from the characterization through and including the remedial phases of an environmental investigation, providing a cost effective, efficient, and technically sound approach to environmental work and research.



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